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"Brief Survey of Operational DECISION SUPPORT SYSTEMS"

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EXECUTIVE SUMMARY

The purpose of this project was to conduct a brief survey and analysis of three operational Decision Support Systems (DSS) in the private sector and one experimental system which lead to 15 applications in the public sector. The three public sector DSS were RCA IRIS, Gould Corp. WINS, and First Chicago EIS. The experimental system was the IBM GADS, and specific attention is directed at the San Jose - Police Beat application. A literature survey was conducted in order to develop a methodological framework for the survey. The methodology selected was to examine each system in terms of 1) the operational environment in which the system was developed, 2) the major events, individuals and actions that influenced system design and implementation, 3) system architectures (User-Software-Hardware), and 4) major operational characteristics (i.e., Internal Security, Training, Maintenance and Support).

It was concluded that a number of similarities were exhibited in all of the four systems examined: 1) three to four years were required for development and implementation, 2) each system had the strong support of the senior management or Chief Executive Officer when development was initiated, 3) all systems had a "broker" who coalesced user, technical and management interests for common support for development and implementation, and 4) all systems had a capability for evolution or "architectural adaptability." It was also concluded that DSS development in the public sector is much more difficult than the private sector because of the need in the public sector for contract specifications and performance standards which currently are virtually nonexistent. Internal security is of great importance in the private sector for multi-level users of DSS with widely dispersed terminals, but was of little concern for public systems. Of the four systems, the RCA IRIS represents the best overall example of an operational DSS which has become institutionalized in an organizational setting, is capable of architectural adaptation, is used by both corporate staff and operational unit managers for both strategic and tactical decision making in the field of personnel management, has an effective internal security system, a good training program, has an effective on-line operational cost/effectiveness evaluation system, and satisfies the dual perceptions of the senior corporate executives as well as the field units without disturbing organizational integrity.

Based on the survey it is recommended that AIRMICS take immediate action to organize a DSS workshop with representation from successful operational systems who would conduct hands-on demonstrations and present case studies, vendors to present the state of DSS software and hardware technology, academicians who represent the major disciplines involved in DSS R and D, and potential Army users who have potential areas of application. It is also recommended that a research effort be initiated to examine the current state of DSS evaluation methodologies and their compatibility with DOD policies and to recommend alternative solutions. Finally it is recommended that after a review and critique of this report is completed, that a second iteration be initiated with a refined set of factors and attributes. The second iteration would be directed at an investigation of a more selective target set and a bigger sample of operational systems which could provide a more definitive baseline to guide the Army in applying DSS technologies to Army computer systems.

1. INTRODUCTION

1.1 Purpose

The Management Information Science Division of AIRMICS has begun a research program to investigate the potential application of Decision Support System (DSS) technologies to improve the operations of business type electronic data processing (EDP) systems used by the Army. As part of this program, it was decided that a baseline survey and analysis should be made of a cross section of DSS currently in use within the civilian community. As given in the Statement of Work for this survey (Appendix A) the objective is "to produce an analysis of existent DSS and their supporting hardware and software technology base, and to recommend further research into potential applications of this technology to computer systems." Specific tasks include "gather and analyze published work on DSS developed for use in the civilian community", and "review and analyze reasons for success or failure of DSS developed for civilian use." As a minimum a detailed investigation was required of the IBM Geodata Analysis and Display System (GADS), the First National Bank (Chicago) Executive Information System (EIS), the Gould Corp Worldwide Information System (WINS), and the RCA Industrial Relations Information System (IRIS).

1.2 Methods and Scope

Work under this study was restricted to twenty man days of effort during the period 30 August 1978 to 15 January 1979. One half of the effort was devoted to informal staff discussions, literature review, and report writing in the Atlanta area, and approximately ten days were spent on field trips to IBM - San Jose, California, First National Bank and Gould Corp., Chicago, Illinois, and to the RCA Corporate Operations Research Staff at Princeton, New Jersey.

1.3 Organization of Report

Chapter 2 gives a summary of the literature review including an aggregated list of DSS descriptive attributes and operations. Chapter 3 discusses the survey methodology which is centered around the investigation of the life cycle evolution of the four specified experimental or operational DSS in terms of their operational environments, major events, architecture, and operational characteristics. Chapters 4 through 7 are dedicated to a discussion of each system individually, but from the same methodological overview. Finally, Chapter 8 presents a synthesis of overall conclusions and a set of recommendations for future Army research. The bulk of the material collected for this project, such as user manuals, corporation reports and examples have not been made part of this report, but will be made available to AIRMICS as the need arises.

2. LITERATURE REVIEW AND DEFINITIONS

2.1 DSS Concepts and Taxonomies

Since the early 1970's the term "decision support system" (DSS) has been increasingly used in management science, operation research and computer system publications to denote an interactive, computer based system which is designed to aid executive level professionals in solving ad hoc, unstructured problems without acquiring a knowledge of programming techniques. Typically, these systems are distinguished from the more traditional EDP applications, which are said to be designed to automate clerical tasks and to promote efficient record keeping. Although a certain amount of conjecture has been generated concerning the "nature" of decision support systems, the importance of interactive problem solving, the relevance of certain system characteristics, the need for special implementation skills and design processes, and so on, there is little empirical data and the conjectures are often contradictory. In addition, there is little agreement concerning general scope, definitions of terms, identification of variables, and other prerequisites for the coalescence of an organized discipline in which research can take place using standard research methodologies.

As number of investigators here attempted to develop taxonomies of DSS according to usage patterns. In 1975 Alter categorized 56 developmental and operational systems into seven distinct types which he labeled as follows (1):

(1) <u>File drawer systems</u> which allow immediate access to data items.

(2) <u>Data analysis systems</u> which allow the manipulation of data by means of operators tailored to the task and setting or operators of a general nature.

(3) <u>Analysis information systems</u> which provide access to a series of data bases and small models.

(4) Accounting models that calculate the consequences of planned actions based accounting definitions.

(5) Representational models that estimate the consequences of actions based on models which are partially non-definitional.

(6) Optimization models that provide guidelines for action by generating the optimal solutions consistent with a series of constraints.

(7) Suggestion models that perform mechanical work leading to a specific suggested decision for a fairly structured task.

Figure 1 illustrates how Alter collapsed this taxonomy into a dichotomy between data-oriented and model-oriented. Data-oriented systems are usually developed by persons with data processing or computer science backgrounds, whereas model-oriented systems are developed by persons with management science backgrounds, such as accounting, simulation, or optimization.

File Drawer Systems Data Analysis Systems	Data Retrieval	Data-Oriented
Analysis Information Systems	Data Analysis	
Accounting Models Representational Models	Simulation	Model-Oriented
Optimization Models Suggestion Models	Suggestion	

Data-Oriented vs. Model-Oriented Decision Support System Types

Figure 1

Keen and Morton (2) have attempted to define DSS in terms of unstructured, semi-structured and structured decision making at various levels of management activity ranging from operational control, management control to strategic planning. Donovan and Madnick extended this notion to ad hoc and institutional (3). Institutional DSS deals with decisions of recurring nature where the problem definition remains relatively stable once it is understood, though the decision algorithm may be unstructured. An ad hoc DSS is concerned with aiding decision making for a wide variety of problems that are not usually anticipated or recurring. The specific problems are usually poorly defined, the decision is needed very soon, and the decision maker's perception of the problem and even the inherent nature of the problem may change during the process. An ad hoc DSS must focus on responding quickly with needed information and analysis on a one-time basis for a specific decision. A graphical composite of Keen, Morton, Donovan, and Madnick's taxonomy is shown in Figure 2.

2.2 The Multi-Disciplinary Nature of DSS Evolution

A principle reason for the lack of a coalescence of DSS definition and concept is due to the multi-disciplinary nature of their envolutionary development which transcends conventional disiplines in computer science, management science, ergonomics (human factors), operations research and behavorial science. Edelman considers that the development of interactive, time-shared computing, and data base management with high level inquiry languages proved to be the two major breakthroughs in the past decade which permitted development of the RCA Industrial Relations Information Systems (IRIS) (4). Keen and Morton emphasize the confluence of Simon's work on the dynamics of organizational decision making at Carnegie and MIT's work on interactive time-sharing computation which began with project MAC (2). Other investigations such as A. H. Schmidt of Harvard's Laboratory for Computer Graphic and Spatial Analysis and E. Carlson of IBM's San Jose Research Laboratory have emphasized the application of computerized cartography and computer aided design technolgies. L. M. Branscomb, Chief Scientist of IBM, recently emphasized the need for more research in the human factors area to improve human-computer communications (5).

One of the earliest attempts at bridging the multi-disciplinary gap was made at a January 1977 conference on Decision Support Systems at Santa Clara, California. The Conference was jointly sponsored by the Association of Computing Machinery, IBM Research Division, Sloan School MIT, and the Wharton School. The proceedings were published in a ACM publication Data Base, Winter 1977 and were edited by E. D. Carlson (6). Papers reported both experimental and operational results, and included discussions of eight systems such as General Motors Relational General Information Sytem (REGIS), RCA's Industrial Relations Information System (IRIS), First National Bank Chicago's Executive Information System (EIS). Other papers discussed research related to the design of display systems and to attempts

LEVEL OF MANAGEMENT ACTIVITY

TYPE OF DECISION	OPERATIONAL CONTROL	MANAGEMENT CONTROL	STRATEGIC PLANNING	SUPPORT NEEDED
STRUCTURED	1 inventory reordering	4 linear programming for manufacturing	7 plant location	CLERICAL EDP, OR MS MODELS
SEMI-STRUCTURED	2 bond trading	5 setting market budgets for consumer products	8 capital acquition analysis	DSS
UNSTRUCTURED	3 selecting a cover for TIME magazine	6 hiring managers	9 R&D portfolio development	HUMAN INTUITION

INSTITUTIONAL

AD HOC

Figure 2

at improving training programs for users. The conference was attended by about 160 individuals with about half from private industry, and representing all of the disciplines cited above. The flyer for the Santa Clara conference gave another perception of the distinction between DSS and traditional computer-based approaches to problem solving:

> "Decision Support Systems are different from traditional computer-based approaches to problem solving in that they are used to help solve the unstructured problems typical of the decision maker's real world. Unlike the traditional techniques of operations research and computer simulation, Decision Support Systems rely on the decision maker's insights and judgement at all stages of problem solving - from problem formulation, to choosing the relevant data to work with, to picking the approach to be used in generating solutions, and on to evaluating the solutions presented to the decision maker."

Figures 3 and 4 respectively, reflect pictorial concepts of computer aided decision making and a user-DSS system configuration with an intermediary.

2.3 Summary of DSS-User Operations and Attributes

In spite of the lack of a common taxonomy or coalescence of DSS definitions and con-epts, there is a general consensus as to the operations that a joint user - DSS system, (man-software-hardware), should be capable of performing. Alter summarized these operations as (7):

(1) Retrieve isolated data items.

(2) Use a mechanism for ad hoc analysis of data files.

(3) Obtain prespecified aggregations of data in the form of standard reports.

(4) Estimate the consequences of proposed decisions.

(5) Propose decisions.

(6) Make decisions.

Alter noted that the difference between classical EDP system and a DSS is that the EDP - user system can only perform the third operation listed above.

In summary, a review of the current literature on DSS results in the following aggregation of descriptive attributes:

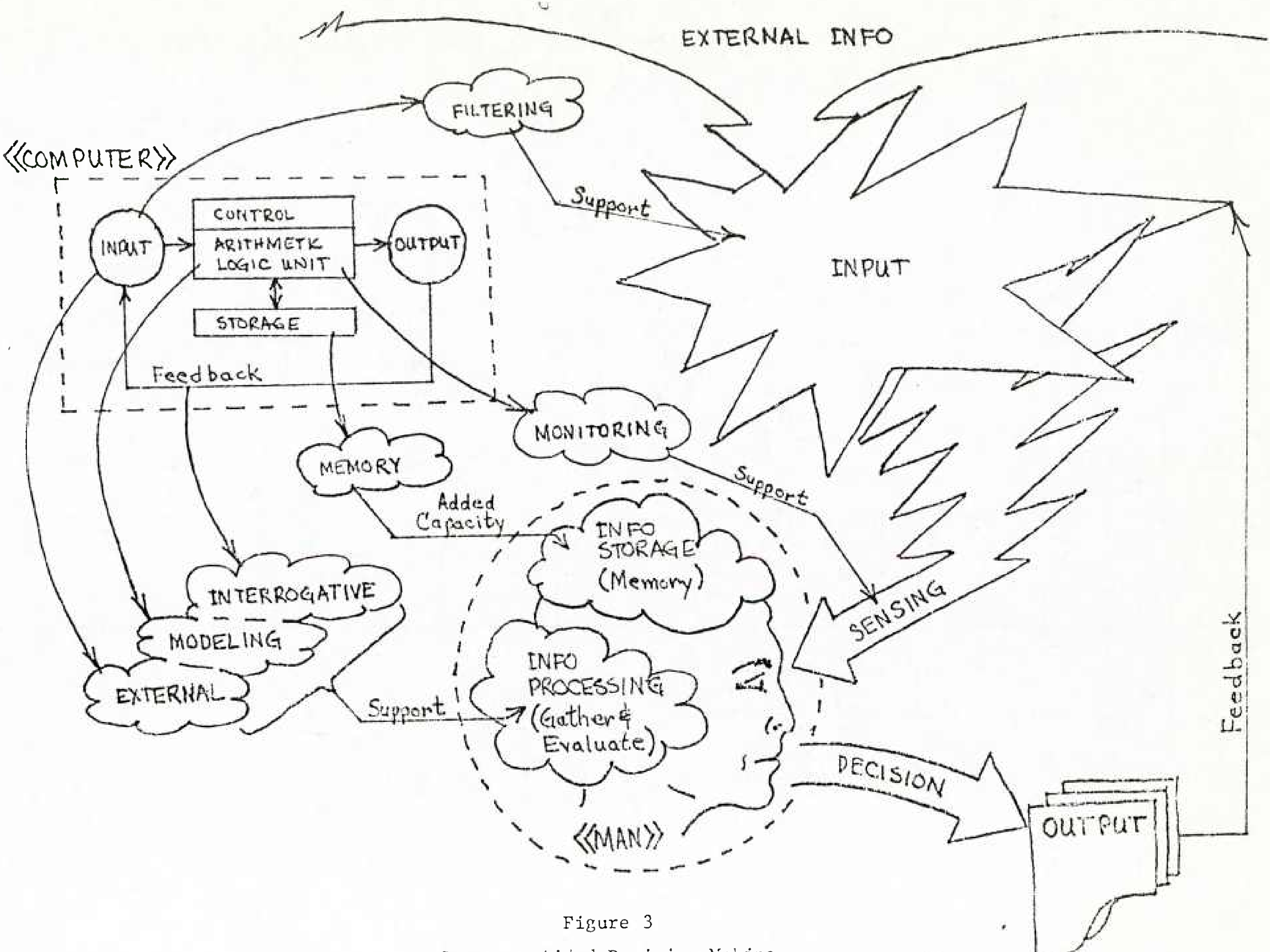


Figure 3

Computer Aided Decision Making

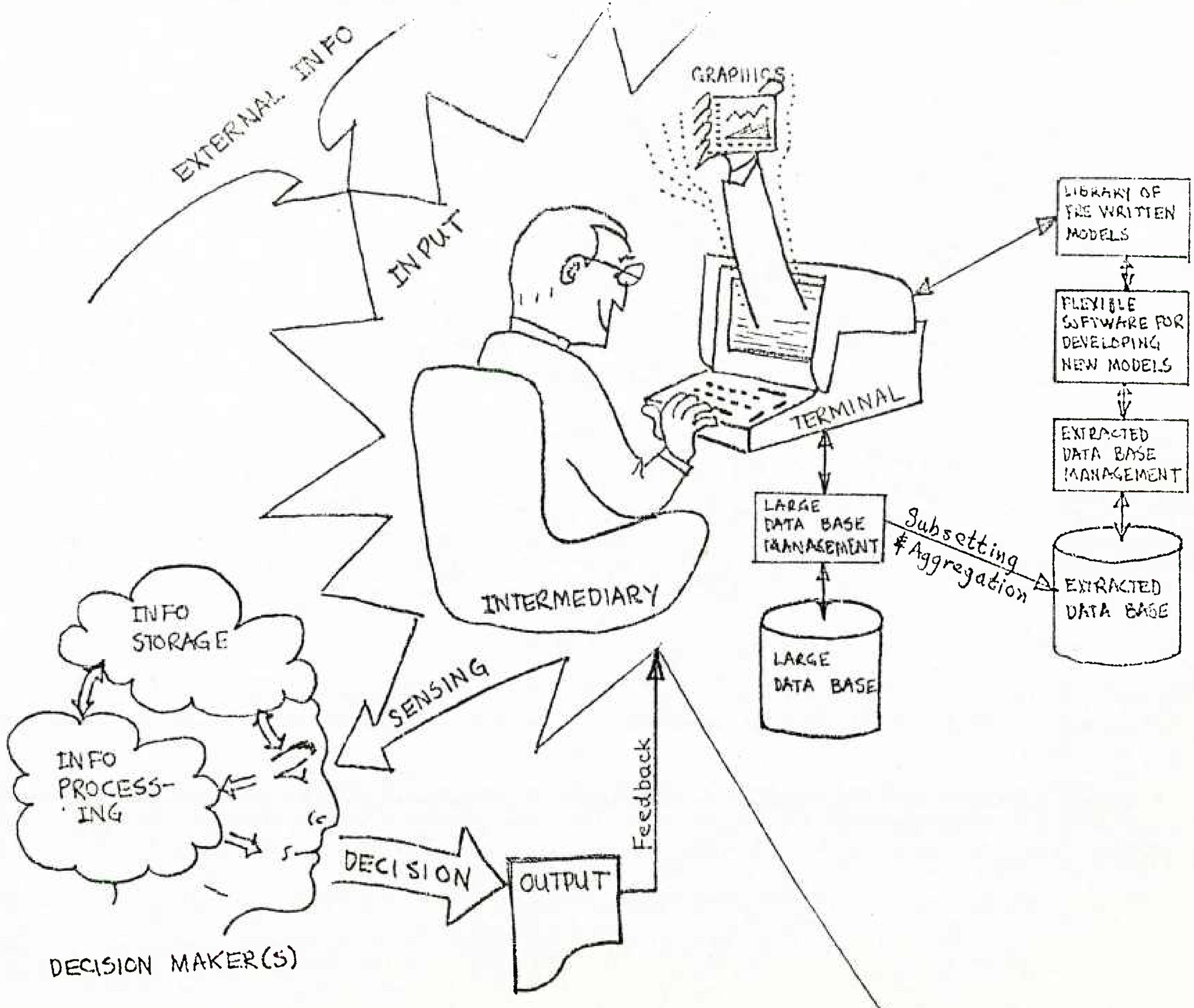


Figure 4

Decision Support System

(1) System characteristics:

(a) A DSS SUPPORTS, not replaces, the decision maker. (Indeed the DSS-User combination may be viewed as a system)

(b) A DSS is USER-ORIENTED; thus, the user should play a key role in the design and implementation.

(2) Decision making characteristics:

(a) A DSS can effectively support both STRATEGIC PLANNING, and Tactical Operations.

(b) A DSS can effectively support SEMI-STRUCTURED decisions, in addition to Structured decisions.

(c) A DSS can effectively support AD HOC decisions, in addition to Institutional decisions.

(3) Users:

(a) A DSS is ADAPTIVE to more than one decision maker or decision making style.

(b) A decision maker(s) may use an INTERMEDIARY (chauffer) to interface with the DSS.

(4) Software:

(a) The DSS is an INTERACTIVE (not conversational) time-sharing system with user-level command language and vocabulary.

(b) The DSS interfaces with an EXTRACTED DATA BASE, a subset of a large data base management system.

(c) The software contains a library of prewritten MODELS.

(d) The software is FLEXIBLE for developing new models for ad hoc, "what if" simulations.

(5) Hardware:

(a) The decision maker(s) or intermediary interact through a terminal device, most mentionably a VISUAL-DISPLAY TERMINAL with graphics capabilities (Other audio and visual cues are sometimes desirable).

(b) The hardware is FLEXIBLE for allowing the decision maker to control representations, operations, and memory aids through suitable entry devices.

3. SURVEY METHODOLOGY

3.1 Previous Survey Methodologies

The literature is replete with examples or case studies of "successful" experimental and operational DSS. However, there has been relatively little documented analysis and discussion of those systems that failed to survive in a competitive business environment or did not live up to the expectations of their sponsors. Alter's 1975 survey of DSS, both successes and failures, provided a rich source of raw-questionaire type data which reflects the opinions of individual users, technicians and managers (1). Further, a growing number of authors such as Keen, Morton and Carlson have begun to investigate the DSS design process itself, the problems of implementation, and the problem of system evaluation (2), (8), (9). Keen and Morton devote four chapters in their 1978 book to these problems, and point out that unlike current practices or in the R & D and Procurement of conventional products, the design, implementation and evaluation of DSS are inseparable and evolutionary. They attribute the complexity of the process to the multi-disciplinary perspectives of the developers, the users and sponsors, and discuss several implementation strategies proposed by Kolb-Frohman, R. L. Ackoff and C. Argris. Keen and Morton conclude that there is need for an "implementor" or "broker" who bridges the gap between the OR/MIS technicians and users, and sponsors. In another paper Morton reports the results of a three year study involving two large operational DSS, and raises two major issues (10). The first is the importance of matching the four components of manager, organizational structure, DSS technology and the tasks which change after the DSS is introduced in the operational environment of the real world. The second is the difficulty of measuring the impact of such systems. He stresses the need for the development of new methodologies that allow the measurement of some of the variables.

3.2 Selected Approach and Factors

The methodology adopted for this study is more structured than the taxonomy-interview approach used by Alter. However, it is not as formal as the work of Keen and Morton which is directed at the modeling, analysis, and quantitive evaluation of the entire design-implementation process for DSS. Our approach is to investigate the evolution of only four mature and widely publicized DSS over their individual system life cycles. This approach was adopted because the four systems of interest, CADS, WINS, EIS, and IRIS each gestated in different operational environments with different types of management sponsorship, emphasized different DSS technologies and architecture, and are designed for different types of users to meet different types of operational requirements. CADS was developed an an experimental system to serve primarily as a research tool for assisting non-program users in the public sector to solve unstructured problems in the San Jose area related to urban growth, definition of school district boundaries, and design of police beats. WINS was developed in a large international conglomerate environment for use by the CEO and other senior executives. EIS was designed for use in a large bank by "first line" loan managers as an add-on to an extensive data processing system. IRIS was developed in a large industrial corporation as both a MIS transactional system and DSS for the solution of ad hoc, unstructured problem solving in the area of personnel management. Due to the time constraints of this research, and the small sample size of DSS surveyed, no attempt will be made to formally rank order or to determine the "best" system. Rather, our approach is to investigate the similarities and difference of the four systems through an examination of each system in terms of:

1. The operational environment in which it was developed.
2. Major events, individuals and actions that influenced system design and implementation.
3. System architecture (User-Software-Hardware).
4. Major operational characteristics.

Based on an examination of the individual systems, general conclusions and recommendations will be made to guide the Army in future research.

The term "operational environment" denotes a brief description of the organizational and administrative setting in which the DSS was developed. The description is limited in scope and content by the terms of the research effort, and is based on interviews with a limited number of personnel during a short field trip, a perusal of corporate documentation, and the author's background and experience. An attempt will be made to identify the key "implementator(s)." The second area of major events in system development is based both on interview and published material. In the third area, the term system "architecture" rarely appears in the DSS literature, although it is commonly used in the discussion of MIS and military "command and control" systems. For purposes of this investigation "architecture" is considered as the art or science of building systems for human use through the application of engineering technologies. Thus, the User-DSS is viewed as a system entity which include the hardware, software and human components. The hardware includes general purpose time-sharing computer systems, graphic terminals, micro-processors, keyboard and non-keyboard entry devices, graphics terminals and telecommunication networks. The software includes data-base management systems, operations research models and algorithms, specialized simulations, and graphic packages. In some cases human component includes both the user decision maker and, the "chauffeur" who acts as an intermediary such as a technician or staff officer as indicated in Figure 4. The fourth area of operating characteristics denotes a number of factors that can be used to examine the entire class of operational DSS. They include:

(1) internal security for users
(2) tactical operations or strategy planning (implies decision time horizon, level of aggregation of data base, and frequency of usage)
(3) level of individual user (implies use by CEO or first level managers, or joint usage)
(4) individual decision making or group consensus
(5) use of central data bank
(6) internal dual systems perspective (implies both corporate and operating units perceptions of system utility)
(7) architecture adaptability

4. INDUSTRIAL RELATIONS INFORMATION SYSTEM (IRIS)

4.1 Operational Environment

The RCA Corporation is a large industrial conglomerate with 1977 sales of 6 billion dollars and employees over 110,000 personnel. Although traditionally a national leader in electronics research and development, and in commercial broadcasting and communications, RCA began to branch out into other industries in the 1960's. It currently owns Coronet Industries in the carpet manufacturing industry, the Hertz Corporation, Random House and Oriel Foods. Corporate offices are located in New York City with seven major operating field divisions or subsidiaries, each with their own profit and loss responsibilities. In the Industrial Relations (human resources) area, there are seventeen different personal management units which maintain complete compensation and performance records for all employees including the corporate staff. Many of these units developed their personnel policies, record management procedures and report styles during the period prior to the time their companies became part of RCA. Consequently, there was a wide variety of responses in their adaptation to EDP technology in the 1960's to solve problems related to payrolls, pension plans, administration, insurance, labor relationships, affirmative action programs, and many other personnel actions, including computerized in-house telephone directories. Many of EDP applications were not developed as systems, but loose confederations of computer programs. Each such system usually existed and operated on a stand alone basis, with little consolidation of reports or use of common data bases.

4.2 Major Events in the IRIS Development-Implementation Cycle

In early 1973 the Corporate Operations Research Group under F. Edleman, was called in by the Corporate Vice-president for Organization Development and Compensation Planning, to discuss the problem of retirement plan administration. The EDP system existent at that time, was not working and incapable of responding to either changing governmental regulatory demands at the tactical operating level, or the needs of corporate management for strategic planning. All ad-hoc unstructured studies were accomplished on primarily manual basis by special task forces. After investigation of suitable financial and actuarial models, and prelimenary field work, the OR group in early 1974 conceptualized, and selected the architecture for a DSS for use by non-computer oriented Industrial Relation managers and administrators and to serve both operating units and corporate management. One of the operating units agreed to supply all its operational data and to serve as a prototype field demonstration.

In July 1974, with corporate backing, a live system was successfully demonstrated to all of RCA's top Industrial Relation executives. The demonstration included live and ad hoc usage by the executives in attendance. As a result of the successful demonstration, the system was named IRIS and the OR group was commissioned to design and build the entire system and install it in all of RCA's major operating units. By the end of 1974, the system, included all custodial functions, and was sufficiently complete to capture and validate the operational data base of a prototype unit, and work began to develop data base maintenance procedures. In April 1975, the pilot system began regular processing of operational transactions in parallel with the then existent personnel data system. In August 1975, IRIS software was transferred from the original laboratory environment at Princeton which used an outside time-sharing ventor to RCA's internal computer facility at Cherry Hill, New Jersey. In September 1975, the prototype unit became completely dependent on IRIS and shut down its old system. By the fall of 1978, all but one RCA personnel department relied on IRIS. With a 6 month transition time, all divisions will be on line by the spring of 1979.

4.3 IRIS Architecture

4.3.1 General

IRIS was designed and developed for simultaneous and joint usage as a transactional EDP report generating system and as an ad hoc DSS for personnel managers and administrators. The entire system uses a common data base and a commercially available data base management system which is programmed on a centrally located and RCA operated IBM 370/168, located at Cherry Hill, New Jersey, under VM/CMS. In addition, the IRIS common data base is used by a number of other EDP systems for analysis and processing, i.e., payroll operations. An extensive command language sector has been custom designed to stand between the end user and the data management system. This "Executive Language" interface is largely responsible for providing the type of human engineering needed to accommodate the noncomputer-oriented user. A wide variety of user terminals are supported, from teletype to high-speed video displays. An extensive data communications network supports the system on a national basis.

4.3.2 User Language

The user communicates with the system through compact and easily learned language at three levels:

- The "command language" conveys to the system the user's basic intent of what he is trying to accomplish: the creation of a new report request, the changing of an existing report request, perusal of the library, logging out and others. There are altogether 15 basic commands. Each command is a single word which, when entered, will initiate the requested procedures and generally assist the user if he needs help.

- The "report request language" is used to phrase a particular report request. It has a syntax which is manageable by noncomputer-oriented individuals and is easily learned after relatively short exposure. A formal course and manual are made available to all system users of the ad hoc sector.
- The "request editing language" is used to change an existing report request and is the simplest and most compact of the three.

4.3.3 Data Management

Even though the system has the data base online for inquiry and analysis purposes - an essential requirement for an effective ad hoc capability - the updating of each data base takes place in an off-line batch mode. This is done for two reasons. First, it is much cheaper, and personnel data does not literally have to be up to the minute. Once a week updating is sufficient in most instances. Second, on-line updating is somewhat more risky from the systems reliability point of view and, at times, enormously so. Hardware or communication line malfunctions during on-line updating can cause problems from which it is often difficult to recover. In this instance, the designers ddopted a concervative but economical and time-proven approach, and to date there has been no indication whatever that a different course might have been more advantegeous for their type of application.

4.3.4 Sample Data Base Concept

To minimize cost of ad hoc usage, an inexpensive means for testing new report request procedures is provided by the system. The data base of a typical operating unit may contain 8,000 to 10,000 people or even more. It would be needlessly expensive to use all of this data in a trial run of a newly developed request. The IRIS system, therefore, provides a small but representative sample of about 100 individuals as a sample data base which is involved for checkout and then replaced by the full data base for actual execution. A simple, one-word command accomplishes each change.

4.4 Operating Characteristics

4.4.1 General

The OR corporate staff at Princeton has a complement of approximately

80 people. One of the major activities of this group is the operation of a central Project Office which exercises technical and administrative control over the IRIS system. In addition an IRIS "coordinator" is located at each operating unit and is responsible for introducing system changes, acting as a "chauffeur" for personnel managers, and the conduct of user training programs. The Project Office itself monitors execution of regular production runs, handles special requests, answers questions dealing with data flow (both input and output), and also serves as the clearing house for requests from user organizations for additional assistance in the application of the system. Each business making use of this system is responsible for the preparation of its own data for submission to the system. When a user goes into a production mode, a regular schedule is set for periodic, usually weekly, updates. The user organization must see to it that its transaction data are ready to meet this update schedule. The actual initiation of the scheduled computer runs is controlled by the central Project Office. Reports of changes made, errors found, and other transaction-related information are sent back to the user organization. The user organization is responsible to see to it that errors are corrected and that the data base is kept up to date and correct.

Finally, the Project Office continuously tests the validity of the data base and periodically, usually once a year, 'restructures' the system. The necessity for restructuring comes about for a variety of reasons. From time to time some of the users will require additional data items to be kept in the data base. During the implementation phase and the early use of the system, these additional items are accommodated in a special sector within the data base which contains only locally useful data. If a number of users require the collection of the same data, then it is highly desirable to transfer these data items from the local sector into the standard Corporate sector. It may also be necessary to expand application capabilities or to streamline the system to gain more efficiency in updating or in reporting from the data base. In short, system restructuring serves the purpose of keeping the system current with changing, real world requirements.

4.4.2 Internal Security

This factor is generally the first and foremost concern of managements of operating units contemplating coming on to the system. System and data security is enforced at essentially two sequential levels. The 'Access' password identifies individuals authorized to enter the system, and the 'Need To Know' password screens for clearance to access specific portions of the file, such as that containing compensation information. Passwords are frequently changed in conformity with corporate policy which recognizes the requirement for satisfying both the needs of the operating unit, and the corporate management. The system is designed to have sufficient merit and utility to be of value to level operations, but be able to cope with company wide issues. Thus, the Corporate staff does not have automatic access to the data and reports of the operating units. At the same time, rigorous standards of data language have been provided for to assure that all units call each data item by the same name. Both Corporate and operating unit user perceptions of the system have been tailored to the identity and responsibility of the user.

4.4.3 Training

Taining is provided at two levels. One is concerned with proper preparation of input data, using the codes and forms provided by the system. The other pertains to use of the system and is geared to the non-computer oriented manager. It teaches the language of the system to perform analysis on the data contained in the data base. Originally training for non-computer oriented individuals began as a one day session, but now has been extended to a two day program. The local IRIS 'coordinator" is then available for follow-up instruction on a ad hoc basis. An elaborate IRIS User Guide of over 400 loose leaf paper is available to each user. (Copy available is author's files)

4.4.4 On-Line Evaluation

Prior to full implementation, the Project Office estimated the costs of operation based on experience gained during the pilot implementation of the system. As mentioned earlier, one of the unique features of IRIS is that the pilot implementation served as the initial version of the system under actual conditions. In the course of this initial implementation, the costs of operation were carefully collected to be used in making realistic projections. They were then unitized so that they could be applied to other parts of the Corporation. A typical business and its operations were used to arrive at a figure of merit to be used for estimating system cost for one employee for one year. The cost was calculated

AGE 1

EPORT BILLYTD MOU: PES RUN: 08:47:00 ON 12/05/78
IS COST PERFORMANCE - FROM 7809 THROUGH 7811

...	MOU	EMPL.-MONTHS (000S)	TRANS. VOLUME (000S)	STARTUP COST ($000S)	UPDATE COST ($000S)	OTHER REGULAR ($000S)	TOTAL REGULAR ($000S)	AD-HOC COST ($000S)	TOTAL COST ($000S)	AD-HOC COST AS % OF TOTAL	NO. TRANS /EMPL /YEAR	COST PER TRANS	REG. COST /EMPL /YEAR	AD-HOC COST /EMPL /YEAR	TOT. COST /EMPL /YEAR
PER.	AKC	6.2	11.0	.0	.4	1.4	1.8	2.4	4.2	57.9	21.4	.04	3.44	4.72	8.16
	AMC	1.7	1.6	.0	.1	1.0	1.2	.7	1.9	38.9	11.4	.09	8.16	5.20	13.36
	BFC	1.9	.7	.4	.1	.8	.9	.6	1.9	40.4	4.3	.16	5.52	3.74	9.25
	CED	44.4	45.9	.0	2.8	15.2	18.0	7.6	25.6	29.8	12.4	.06	4.86	2.07	6.93
	COR	5.3	10.2	.0	.6	1.1	1.6	.5	2.1	23.2	23.1	.06	3.69	1.11	4.80
	GCS	13.0	11.1	.0	.6	5.8	6.4	5.7	12.1	47.0	10.2	.06	5.89	5.23	11.12
	GLO	9.5	11.3	.0	.6	2.9	3.5	2.8	6.2	44.5	14.3	.05	4.37	3.50	7.87
	HTZ	58.0	116.6	.0	3.5	8.4	11.9	5.6	17.5	32.0	24.1	.03	2.46	1.15	3.61
	LAB	5.8	9.7	.0	.7	5.1	5.8	6.8	12.6	54.2	20.2	.07	12.00	14.19	26.19
	LTD	19.8	28.8	.0	1.1	3.3	4.4	3.9	8.3	46.8	17.4	.04	2.66	2.34	4.99
	NBC	25.4	23.6	.0	2.0	9.5	11.5	10.0	21.4	46.4	11.2	.08	5.43	4.71	10.14
	PTD	36.1	34.8	.0	1.2	6.2	7.4	12.1	19.5	62.0	11.6	.03	2.47	4.02	6.48
	REC	23.4	31.3	.0	4.4	9.4	13.7	6.8	20.6	33.2	16.1	.14	7.05	3.51	10.56
	SSD	25.9	10.3	.0	.8	4.6	5.5	6.7	12.1	55.0	4.8	.08	2.52	3.09	5.61
	STF	3.8	1.5	.0	.5	.7	1.2	2.0	3.1	62.5	4.7	.32	3.70	6.15	9.85
TOTAL	OPER.	280.2	348.4	.4	19.3	75.3	94.6	74.1	169.1	43.9	14.9	.06	4.05	3.17	7.22

Figure 5

IRIS Performance Data

```
15:26:22 ENTER FUNCTION .R GRIFF2
$
*** CHARGES START AT: $56.78; USING FULLDB ***
*** TO ABORT RUN: HIT 'BRK' KEY AND TYPE 'HX' ***

RAMIS II 1.3.00    05/22/78     A PROPRIETARY PRODUCT OF MPG
>
 DATABASEDATA     84
>
>
>
>

  NUMBER OF RECORDS IN TABLE=      32  LINES=     32

 PAGE      1


 REPORT GRIFF2   MOU: DEM      RUN: 15:26:51 ON 12/14/78
GRADUATES OF GEORGIA TECH
```

LAST-NAME	OCCUP.TITLE	DEG-NAME	DEG-YR	MAJOR-NAME
APOSTOLU	CONTRACTS ADMIN	B	51	IND'L MANAGEMEI
BEEBE	MGR EQUIP ASSY & TEST	B	51	INDUSTRIAL ENG
BENNETT	MEMBR ENGRG STAFF	B	50	MECHANICAL ENG
BENTON	SENIOR MBR ENG STAFF	A	65	INDUSTRIAL ENG
		A	65	IND'L MANAGEMEN
CURTIS	UNIT MGR ENGRG STAFF	M	59	COMMUNICATIONS
ERICKSON	SENIOR MBR ENG STAFF	B	54	ELECTRICAL ENG
GREER	MEMBER TECHNICAL STAFF	M	72	PHYSICS
HALL	SENIOR MBR ENG STAFF	M	71	COMPUTER SCIEN
HAMMEL	SENIOR MBR ENG STAFF	B	54	ELECTRICAL ENG
HANAGUD	ENGINEER	M	71	MECHANICAL ENG
HEROLD	UNIT MGR DES & DEV ENGRS	B	50	ELECTRICAL ENG
HOBBS JR	PRINCIPAL MBR ENG STAFF	B	40	ELECTRICAL ENG
HOLSHOUSER JR	MGR EQUIPMENT DESIGN	M	49	ELECTRICAL ENG
HUMPHRIES JR	MBR ENGRG STAFF	B	73	ELECTRICAL ENG
KITCHENS	UNIT MGR SYS ENGRG	B	55	ELECTRICAL ENG
MERCER JR	MGR PROD ENGRG PROJECTS	B	48	ELECTRICAL ENG
NESSMITH	MGR SYSTEMS TECHNOLOGY	B	47	ELECTRICAL ENG
NEWBORG	MGR ANTENNA PRODUCT MGMT	B	43	ELECTRICAL ENG
NOWAK	SENIOR MBR ENG STAFF	M	74	ENGINEERING (O
OGAN	ASSOC ENGR	M	71	OTHER
OHARA	MANAGER DESIGN ENGRG	B	66	PHYSICS
PRIDGEN	SENIOR MEMBR ENGRG STAFF	M	71	ELECTRICAL ENG
SAYE	TECHNICAL PLANNING REP	B	65	PHYSICS
SEABORN	MGR PROGRAMS	B	56	AERONAUTICAL EI
SHANNON	MGR ELECT WARFARE SYS	B	49	ELECTRICAL ENG
SPARKS	PRINCIPAL MBR ENG STAFF	B	52	ELECTRICAL ENG
STRICKLAND	SENIOR MBR ENG STAFF	B	50	ELECTRICAL ENG
TINDALL	MGR ADV SYS TECH	D	71	OPERATIONS RESE
WILLIAMS	MGR BUSINESS PLANNING	B	40	MECHANICAL ENG
WILSON	SENIOR MBR ENG STAFF	B	60	ELECTRICAL ENG
WYANT	MANAGER DESIGN ENGRG	B	54	ELECTRONICS EN

```
>
*** CHARGES END AT: $61.97; ***

15:29:44 ENTER FUNCTION .LOG
$CONNECT= 00:56:45 VIRTCPU= 000:25.50 TOTCPU= 000:49.95
LOGOFF AT 15:29:55 EST THURSDAY 12/14/78
```

to be between four and five dollars per person per year. These costs are carefully monitored for all IRIS operations throughout the Corporation. In almost all cases, the actual costs have been below the initial estimates made. Actual cost experiences above initial estimates are attributable to more extensive system use then may have been originally contemplated. Figure 5 shows a typical cost performance report for the Quarter September - November 1978 for each of the major operating units. It also reflects the dual transactional - DSS nature of IRIS which now approach average usage patterns of 55% transactional and 45% ad-hoc DSS. It also indicates that usage appears to be at four levels enumerated here in approximate frequency:

(1) Ad hoc analysis of existing data,

(2) Prespecified aggregations of data (i.e., standard reports),

(3) Evaluation of consequences of proposed decisions, and

(4) Retrieval of isolated individual data items.

Figure 6 gives an example of an ad hoc query by the author of this study as to "How many Georgia Tech graduates work for RCA?"

5. EXECUTIVE INFORMATION SYSTEMS (EIS)

5.1 Operational Environment

The First National Bank (Chicago), or First Chicago, is a one-bank holding coproration with First National Bank its principle asset. Chartered in 1863, First Chicago is the oldest national bank in existence, and has accumulated assets of over 22 billion dollars. Under Illinois law, the bank has no branches, but operates primarily as a national and international commercial bank with installations in 37 countries, on six continents, and in most major cities in the U. S. First Chicago has developed close ties in account relationships with Montgomery Ward, Sears Roebuck, Wm. Wrigley Co., Inland Steel and Firestone Rubber, and serves as registrar and transfer agent for corporate securities and as underwriting house for municipalities.

Day to day operational or tactical decisions, are made principally by 400 Loan Officers who operate as P & L managers with their own profit center. These Loan Officers require data bases and in-depth analysis on 60 different industrial sectors ranging from fast food branches to marine shipping. Longer range strategic, planning, decisions are made by committees from the Board of Directors. A key Board committee is the Asset and Liability Committee which sets the weekly rate for CDs and determines target customer industries.

5.2 Major Events in System Design Implementation

In April 1972, at the instigation of Gaylord Freeman, a senior First Chicago executive, a joint venture between IBM and First Chicago was initiated to analyze executive decision making within the bank's organizational structure, and to determine how a DSS might lend assistance to bank managers. Mr. Freeman later served as chairman of First Chicago from 1974-1975 during the crucial period of IRIS development. A joint IBM-First National team was established, and postulated that to identify viable alternatives, it would need to:

(1) Extend the data available from the executives' computer systems to include external and internal information resources potentially available to them in setting the policy direction for the institution.

(2) Provide more sophisticated techniques to evaluate both short-range and long-range growth and profit objectives.

The team further established that the study should consist of the following phases:

(1) Analyze the existing structure for information flows, available sources and current processes employed. This beginning phase would describe decision supporting systems as they currently existed.

(2) Identify current deficiencies in these processes, sources and flows.

(3) Recommend action. The makeup of the team admittedly lent a bias toward an automated, computerized action. Yet the charter implied a solution quite different from that of the application-directed systems then in existence. Prior to this joint venture, system development activity was aimed at automating clerical processes and providing information for day-to-day management. Reporting systems tended to address the rather parochial needs of the particular operating applications being managed. The team recommendation clearly needed to address a major change in the use of systems at First National Bank.

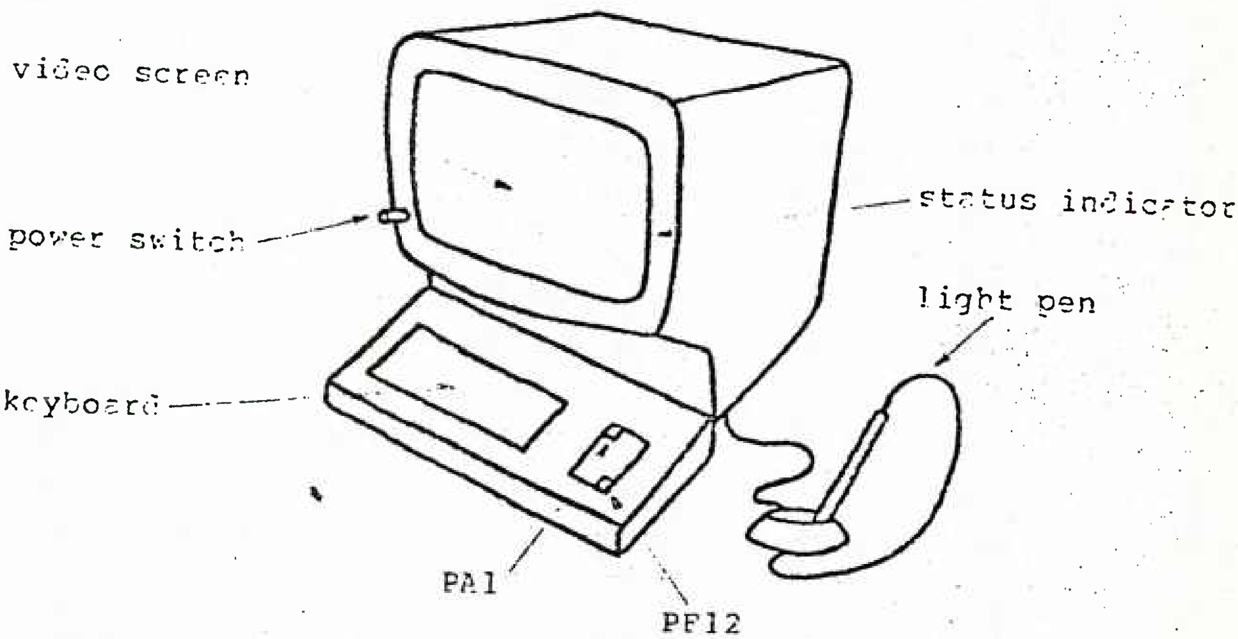
The formal study began in early 1973. In the ensuing months the team interviewed more than 40 executives in sessions consisting of over 300 man-hours. The focus of the study was less on harnessing the power of the com-

THE BASICS

Devices

Terminal

Provides you with the means to communicate with the computer. It consists of a video screen for "menus" and tabular reports, a keyboard and a light pen (see illustration below).



Graphic Display Device

A three-cable color television for graphic displays. All the user has to do is turn it on and off and indicate via the menus that he wants to see a graph.

Graphics Copier

Consists of a printout bin, power on/off switch, copy button, and light/dark copy control. Prints TV display in black and white.

Tabular Printout Device

Prints reports shown on the video screen. All controls are computer-initiated except the carriage to advance paper and power on/off switch.

Figure 7

EIS Terminal

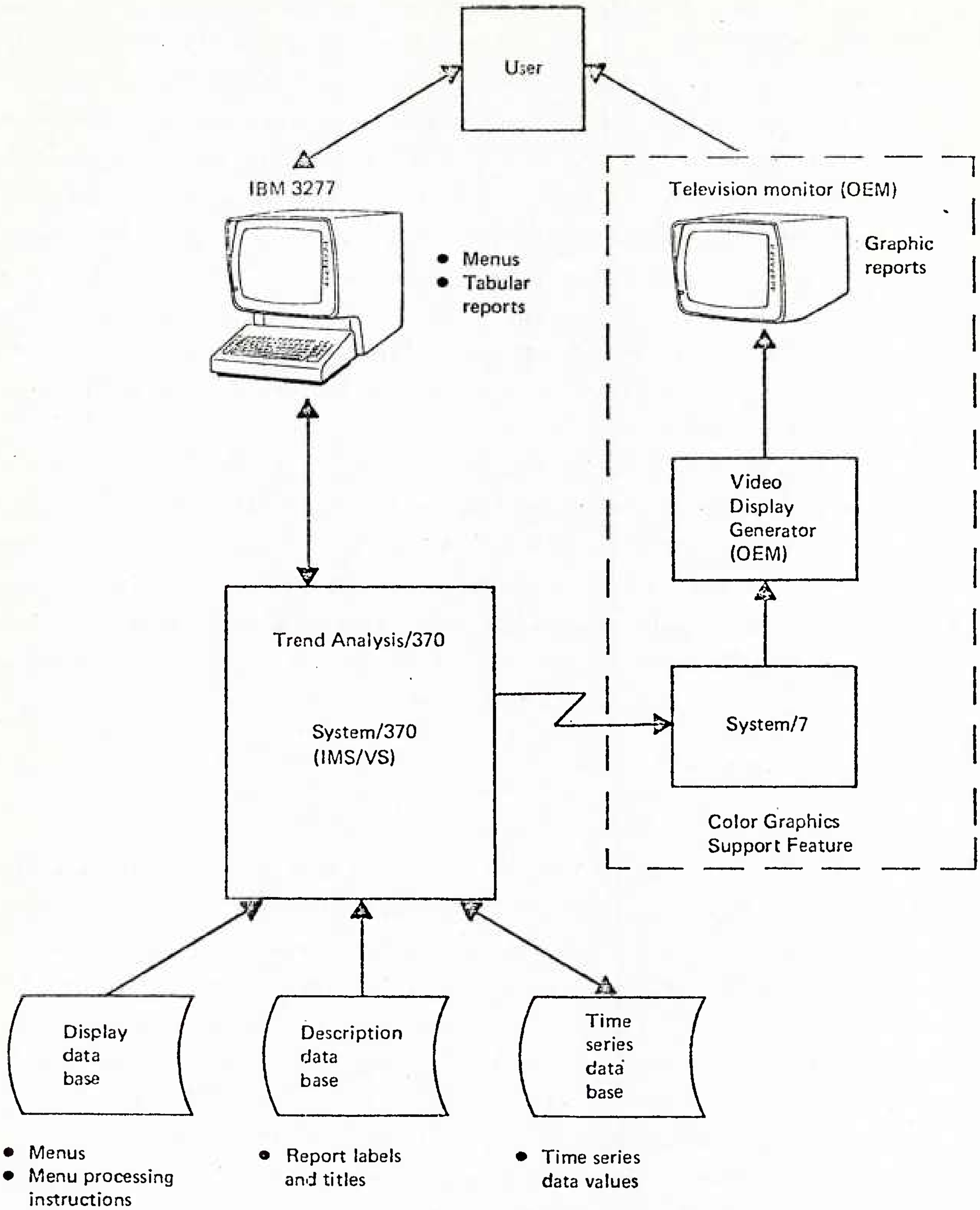


Figure 8

Trend Analysis/370 and the Color Graphics Support Feature puter, and more on understanding the information needed, how it was used and its importance for decision making. Partly for the implicit understanding of the decision-making process and to perhaps better leverage the combined firms' investment, the team participated directly in analytical studies for senior management during this time. Studies using ratio analyses of competing banks, evaluating money market liquidity and analyzing commercial loan commitments were found typical of those frequently requested by a large money center bank. The studies performed continued to substantiate the inordinate data-gathering activities necessary to support analysis: 86 percent of staff time, data gathering: 10 percent of staff time, analysis, and 4 percent of staff time, formating. From the study phase, the team concluded that a mechanism could be designed to facilitate decision making and went about summarizing its findings in a manner suitable to suggest an interactive, computerized approach.

By 1975 a prototype system had been developed that utilized a decision support module which captured the revelant data related to the fast food franchise industry, one of sixty major industries of interest to First Chicago. An EIS staff of about 45 people was organized within the bank with responsibility for development, maintenance and application support in new areas. By the fall of 1978, models had been completed for the remaining industries, and over 100 of the 400 loan managers were full time users of EIS.

5.3 EIS Architecture

5.3.1 General

The EIS architecture is basically the same as that currently marketed by IBM as their Trend Analysis/370. The system consists of a terminal with a keyboard, light pen and black and white video screen, a color television screen for graphics display, a black and white graphics copier for the TV display and a tabular print-out device for printing reports shown on the black and white video screen, Figure 7. The terminal is interconnected to an IMS/VS-based computer program as shown in Figure 8. The terminals are designed for individual site installation in an office sized room. However, at the present time there are two main conference room installations, each with two terminals, and located on different floors in the locale of a majority of the loan officers. There are a few other EIS installations with only a display terminal and printer or TV.

5.3.2 Data Entry

Data can be entered into the EIS data base either manually or through the computer, depending on the form in which the source data is available. If the data is in machine-readable form, then it can be entered into the data base using a computer program. For example, if the data is purchased on a magnetic tape from an external source or the data is available in the Bank's computers for some other system or application, then the data can relatively easily be entered into EIS. If the data is not available in machine-readable form and is to be entered from source documents, then manual input is required. EIS provides data entry screens through which data can be keyed in. Frequently, personnel from other bank divisions assist in data preparation and entry. Depending upon the number of data elements being entered, eight to ten companies' information can be entered in one day.

5.3.3 Decision Support Modules

The system employs a unique concept of decision support modules and menus:

(1) Decision support modules (DSMs) provide the basis for establishing EIS as a utility. Modules consist of a series of related decision options. They are added as aspects of decision processes within the bank are identified and analyzed. IRIS architecture assumes that the need for information for decisions grows more rapidly than most data systems can effectively provide. The module acts like a prototype of the decision process. It allows quick response, but more importantly allows growth in concert with the needs of management. Modules access a common data base and display information personalized to the decision maker's style and patterned to the environment to be managed.

(2) Menus comprise an important aspect of EIS. Modules consist of sets of choices developed to visualize the alternatives to be analyzed for the decision. The menus enable the decision maker to select from a table of earlier choices or to develop new approaches for examining the relevant factors of the decision. Because of the menu concept, persons can become proficient in EIS in little more than one hour.

5.3.4 Comparison EIS and Standard MIS

EIS was designed as an appendage to First Chicago's conventional MIS, and/or as a stand-alone application. Figure 9 shows the features that EIS provides.

Problems of MIS	EIS Features
(1) Lack of decision aids	(a) DSMs distinct and unique (b) ad hoc math functions (c) color graphics (d) stored formulas, routines, reports
(2) Lack of compatability between systems	(a) singular data base (b) standard interface to EIS (c) flexible input methods
(3) Positional rather than directional information	(a) time series data base (b) time function analysis
(4) Wide separation of manager and systems	(a) interactive (b) menu concept (c) light-pen sensitive (d) color graphics (e) personally controlled tabular lists (f) external data available

Figure 9

EIS Features Compared to MIS

5.4 Operating Characteristics

5.4.1 General

Loan officers in the Corporate Banking Department are the primary users of EIS for aid in credit analysis. However applications have been designed and implemented for a number of other users. The Bond Department has money market data on EIS, the Personal Banking Department (PBD) has savings and automatic teller system information on the data bases, and the Administrative Department also uses it. In addition to this, EIS has quarterly Domestic Call Reports and income statement information published by the Federal Reserve Bank for ten years for 413 banks. Balance sheet and income statement information for various companies is carried in EIS. In addition, financial ratios have been predefined and are accessible with EIS. The First Chicago/Bond Department money market customer data base carries information by various types of liability instruments for groups of customers aggregated by ZIP codes and SIC codes. Personal Banking monitors a number of kinds of activity on the automatic teller machine (ATM) system. They can examine individual machines and isolate various transaction totals on a daily basis. Another PBD group tracks trends in the savings and certificate of deposit categories which are offered to individual savers. This data is transferred, daily and automatically, from other FNBC computer systems.

Although the EIS has both the software and hardware capabilities, there has been relatively little usage of the system by individuals of the senior corporate staff. The Asset and Liability Committee does use EIS on a weekly basis to make decisions on sales of the bank's Certificates of Deposit in industrial money markets. However most of the users are lower middle management who had had experience with computer technology in their academic careers.

5.4.2 Internal Security

Data stored in the EIS data base is secure and protected from unauthorized usage. Each EIS user area is assigned an EIS number which identifies the user and the application he will use. In addition, there is a password protection. Associated with each EIS number is a password known only to the users of EIS in that area, and the system can be accessed only if the correct password is supplied. In addition, the sign-on codes and data in the data bases can be arranged so that a number of users can have access to most of the data but any individual user can protect certain private data from access by anyone but himself. All the data resides on FNBC's computers which are protected by the Bank's security force 24 hours a day, and the EIS data can be accessed only through special terminals connected to FNBC's computers. Access requires a knowledge of equipment, sign-on codes, and passwords.

5.4.3 EIS Application Development Cycle

The EIS staff unit is responsible for the development, maintenance, and application support of EIS. EIS has been developed in a fashion which makes the addition of new users relatively easy.

A typical application installation cycle is as follows:

(1) A demonstration of EIS to the user.

(2) Expression of interest in the use of EIS in the user's area.

(3) User department and EIS personnel make an analysis of the information needs and identify potential areas for EIS application.

(4) An analysis and specification of the desired system, with user participation, i.e., sources of data, organizations to be included, data elements, time periods, frequency of the data, method of data entry.

(5) Creation of menus, data base entries, and data entry programs.

(6) User education.

(7) User usage.

(8) After gaining experience with the system and learning the power of EIS, the user generally expands and/or redesigns the current application.

(9) Change of the current application.

5.4.4 Cost and Operational Evaluation

Costs for EIS are borne by the users on an internal fund transfer. Initial programming of an application costs about $1000 with training and educational costs estimated at $200. Operating costs are about .10 per transaction or about $3.00 per report.

6. WORLD WIDE INFORMATION SYSTEM (WINS)

6.1 Operational Environment

The Gould Corporation is a medium size international conglomerate primarily a manufacturer of electronic products whose sales have grown from $350 million in 1969 to over $1.6 billion in 1977 under the leadership of W. T. Ylvisaker who is currently CEO and Chairman. Gould manufactures over twenty product lines, and operates with forty field divisions, each responsible for their own planning, operations and profit center. Gould's products range from automobile batteries, electric motors to the manufacture of copper foil. Over 45,000 employees are managed by a corporate staff of 450 located at Rolling Meadows, near Chicago. In a decentralized management mode, each field division is responsible for its own MIS system for planning and operations. The principle management tool used by corporate headquarters is a monthly core report which sets objectives, resource allocations, and performance criteria for each profit center. This core report plus a weekly status report are the basis for the majority of corporate decision making. Mr. Werner Menck, director of financial analysis, played a major role in developing the performance measures and format for the core report.

6.2 Major Events in WINS Development-Implementation Cycle

In 1972 Mr. Ylvisaker commissioned an outside consultant to build a "war room" for use by the senior corporate executives which would provide graphic displays of information needed for high level strategic planning sessions which would display different representations of all data in the monthly core report. By 1974 dual facilities had been installed in the corporate board room at Gould headquarters in suburban Chicago, and in an adjacent location at Gould Center devoted to management training programs. These facilities included a complete audio-visual system with a large rear-projection TV screen, and were capable of displaying four-color graphs and charts in slide form. The audio-visual system was equipped with an elaborate control panel for the rapid sequencing of displays according to the chairman's dictates. However the early version was incapable of directly interacting with a computerized data base system, and required a large amount of manual processing of data. In October 1975 Mr. Menck was assigned to head a project team which was assigned to solve the software interface problem to present on-line graphics from the computer data base on an ad-hoc basis. By early 1977 the board room system was completely operational. The WINS also included six small screen black and white TV type displays which were designed for use by selected corporate managers as a deck mounted aid for decision making on a day-to-day basis outside of the weekly board room use.

6.3 Architecture

6.3.1 General

The overall WINS hardware configuration is centered around a PDP11/35 minicomputer located at Gould headquarters which interfaces with a remote Burroughs 6700 mainframe at the company's regional center in Cleveland. The PDP11/35 feeds a Ramtek converter that drives a

W I N S   H A R D W A R E   C O N F I G U R A T I O N

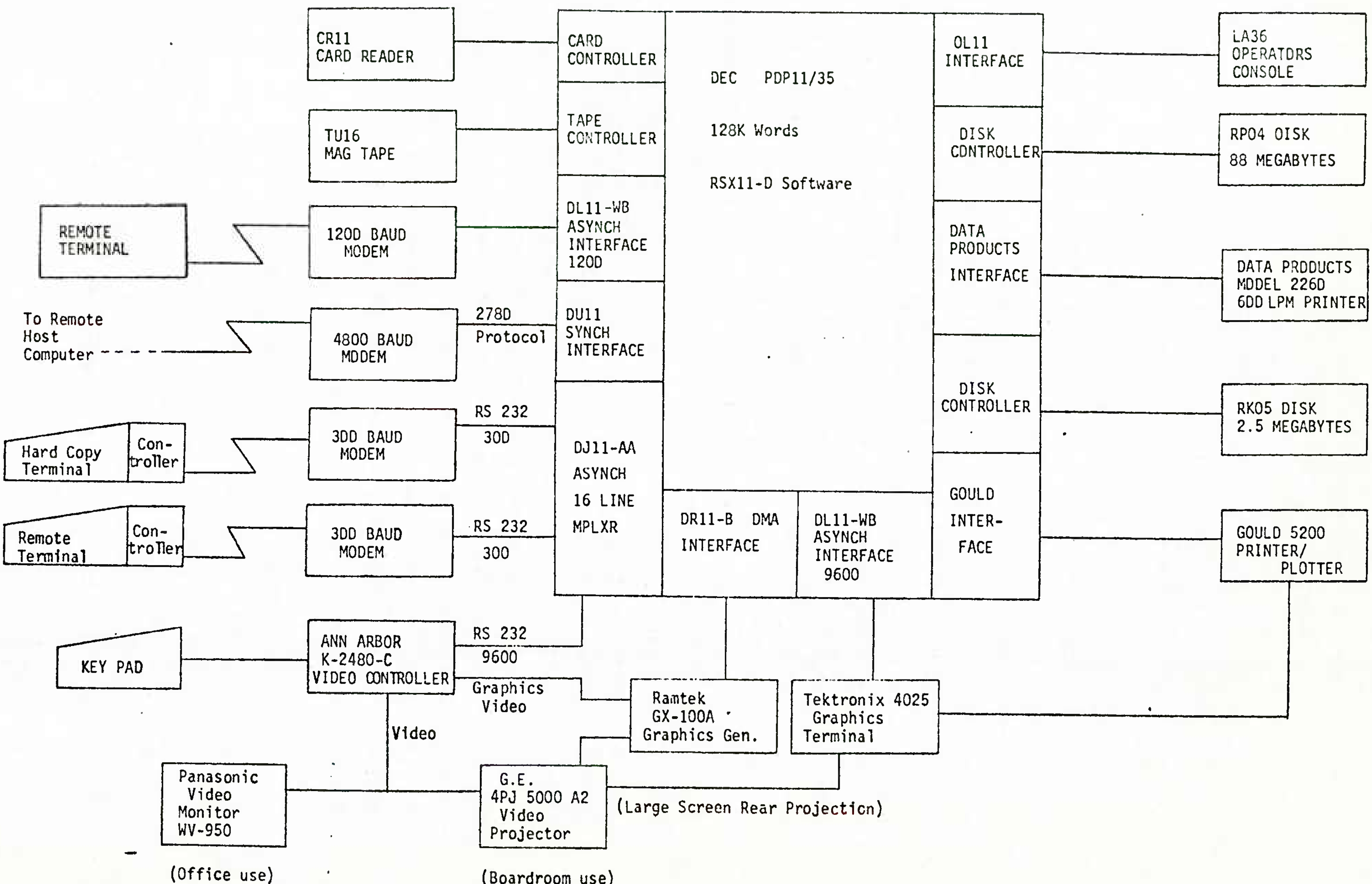


Figure 10

General Electric light valve which projects onto the large screen board room display. To display numerical data the Ramtek converter is by-passed. The six desk top terminals are slaved to the system with both coaxial cable and transmission wire. The whole configuration including ancillary peripheral equipment is shown in Figure 10.

6.3.2 Data Management

Although each division maintains its own computer systems for management and manufacturing, the company maintains a regional computer center at Cleveland. As part of normal monthly closings all division financial data is fed into a central financial data base at the regional center. The data base is structured so as to provide data for the monthly core report which is produced and published for management by the corporate staff on the tenth working day after the close of each month. As the update data files are transmitted to Chicago, they are also recorded on a magnetic tape for input to the PDP11/35.

6.3.3 User Interfaces

WINS was originally designed principally for board room use by the CEO and the senior corporate managers as a "control" rather than "planning" decision aid. In the "control" mode the emphasis was on group or consensus review of data in graphic or tabular format which represented the current state of division operations. As the system evolved more emphasis was placed on the use of corporate models for asking "what if" questions related to planning functions than an individual management might be interested in. The six desk type terminals were designed to be strategically located through the senior management office area so that either the individual, or perhaps groups of one or two senior managers might begin to use the terminals in much the same way they used a telephone or an administrative assistant or a secretary. Based on some simple human factors considerations the following principles were incorporated into the WINS design:

(1) Relatively small amounts of input required (ten-digit maximum for any selection).

(2) Instantaneous response (usually in eight seconds but no more than 80 seconds).

(3) Screen must present all the information at one time for

DIRECTORY

ORGANIZATION UNIT INDEX
(FIRST 3 DIGITS)

Consolidated	CON or 266
Automotive Battery	ABD or 223
IBD-Canada	IBC or 422
Industrial Battery	IBD or 423
Metals	MET or 638
Plastics	PLS or 757
Portable Battery	PBD or 723
Battery	BAT or 228
Electric Systems R&D	ELS or 357
Electric Systems Sales	ESS or 377
Power System	PDW or 769
Switchgear	SWI or 794
Insulator	ISL or 475
ITE Industries-Australia	AUS or 287
Electrical Sys.	ESG or 374
Circuit Protection	CRT or 278
Controls	CSY or 279
Electric Fuse	EFD or 333
Electric Heat	HED or 433
Electric Motor	EMD or 363
Electrical Apparatus	APP or 277
Electrical Components	ECD or 326
Sales	SAL or 725
Electric Products	ELE or 353
Elastomer Products	ELA or 352
Engine Parts	EPD or 373
Foil	FDI or 364
Foundry	FDY or 339
Powder Metal	PMD or 763
Industrial	IND or 463
Fluid Components	CMP or 267
Hose & Couplings	HCP or 427
Valve & Fittings	VFD or 833
Fluid Power	FLG or 354
Biomation	BIO or 246
Electronic Components	ADV or 238
Instrument Systems	ISD or 473
Modicon	MCC or 622
Nucleonic Data Systems	NDS or 637
Measurement Systems	MEA or 632
Instrument & Controls	ICG or 424
Contardo	CNT or 268
Chesapeake Instruments	CHS or 247
Electronic Systems	SYS or 797
Hydrosystems	HSY or 497
Ocean Systems	OSD or 673
Government Systems	GOV or 468

WEEKLY STATUS ITEMS

Receivable Days	BET or 238
Inventory Days	FUN or 386
Payable Days	PAD or 723
Order Backlog	CAT or 228
Orders Received	DOG or 364
Net Sales	SEX or 739
Receivable $	DUE or 383
Inventory $	MUD or 683
Payable $	PET or 738
Overtime $	VUE or 883
Working Capital	CAP or 227
Division Total	TDT or 868

Groups Broken Down by Division

BGD	Battery
ESY	Electrical Systems
EGD	Electrical Products
IGD	Industrial
FLU	Fluid Power
IXD	Instrument & Controls
USG	Government Systems

Total Broken Down by Group

TBG Total Corp. by Group

- -

C - Consolidated

T - Total of Divisions (not consolidated)

G - Group

D - Division

* Indicates the item has Forecast Data

INFORMATION ITEMS INDEX
(SECOND 3 DIGITS)

P & L ITEMS

Full P & L Showing All Major Line Items (C,T,G,D)	PRO or 776
Gross Sales-External (T,G,D)	SOX or 769
Gross Sales-Interco. (T,G,D)	SIN or 746
Sales Deductions (T,C,D)	SON or 766
Net Sales (T,G,D)	SEX or 739 *
Cost of Goods Sold (T,G,D)	COY or 269
Gross Profit (T,G,D)	BAG or 224
Engineering (T,G,D)	SIT or 748
R & D (T,G,D)	WOW or 969
Advertising (T,G,D)	TIN or 846
Distribution (T,G,D)	FEW or 339
Guarantee (T,G,D)	SIO or 743
Other Marketing (T,G,D)	BIN or 246
Total Marketing (T,G,D)	SUE or 783
Administrative (T,G,D)	ANN or 266
Other Expenses (T,G,D)	WON or 966
Other Income (T,G,D)	SUN or 786
Export Incentive (T,G,D)	BUN or 286
Leasing Incentive (T,G,D)	TON or 866
Corporate Allocation (T,G,D)	TOW or 369
PBT (T,G,D)	FIN or 346 *

Balance Sheet Items

Full Consolidated Balance Sheet (C)	GIN or 446
Full Net Assets Employed Showing All Major Line Items (T,G,D)	NET or 638
Accounts Rec.-Total (T,G,D)	DUE or 383 *
Accounts Rec.-Overdue (T,G,D)	PER or 737
Inventory - Materials (T,G,D)	RAW or 729
Inventory - W.I.P. (T,G,D)	WED or 933
Inventory - Fin.Gds. (T,G,D)	LED or 533
Inventory Reserves (T,G,D)	SEE or 733
Inventory Total (T,G,D)	MUD or 683 *
Accounts Payable (T,G,D)	PET or 738 *
Working Capital (T,G,D)	CAP or 227 *
Net Fixed Assets (T,G,D)	FIX or 349 *
Net Assets Employed (T,G,D)	FAT or 328 *

Ratios and Other Items

Net Cash Flow (T,G,D)	MAY or 629
Capital Expenditures (T,G,D)	RAM or 726
Orders Received (T,G,D)	DOG or 364
Order Back Log (T,G,D)	CAT or 228
Export Sales (T,G,D)	SAG or 724
Total Employees (T,G,D)	DUG or 384
Manufacturing Employees - Direct (T,G,D)	CAN or 226
Manufacturing Employees - Indirect (T,G,D)	LAP or 527
Salaried Employees - Exempt (T,G,D)	TAG or 824
Salaried Employees - Non-Exempt (T,G,D)	FAN or 326
Avg. Hourly Wage (T,G,D)	DOE or 363
Index-Selling Price (T,G,D)	MOD or 663
Index-Raw Material (T,G,D)	TAN or 826
Index-Purchased Parts T,G,D)	LUG or 584
Index-Direct Labor (T,G,D)	MAT or 628
Index-IME (T,G,D)	RAT or 728
Variance-Selling Price (T,G,D)	TUG or 884
Variance-Sales Volume (T,G,D)	OLD or 653
Variance-Sales Mix (T,G.D)	RUG or 784
Variance-Cost (T,G,D)	LET or 538
Gross Profit/Net Sales (C,T,G,D)	BOP or 267
PBT/Net Sales (C,T,G,D)	LAW or 529 *
PBT/Net Assets Employed (T,G,D)	CUB or 282
Working Capital/Net Sales (C)	FOX or 369
Net Assets Employed/ Net Sales (T,G,D)	PAP or 727
Accts. Rec. Days (C,T,G,D)	BET or 238 *
Inventory Days (C,T,G,D)	FUN or 386 *
Accts.Payable Days (C,T,G,D)	PAD or 723 *
Sales Per Employee (C,T,G,D)	GAY or 429
Profit Per Employee (C,T,G,D)	JOB or 562
Fixed Assets Per Employee (C)	GOT or 468
Total Assets per Employee (C)	BUG or 284
PAT/Net Sales (C)	DAD or 323
PAT Total Assets (C)	TOE or 863
PAT/Equity (C)	FED or 333
Tax Rate (C)	SOT or 768
Quick Ratio (C)	MOP or 667
Current Ratio (C)	VAT or 828
Liabilities/Equity (C)	TAP or 827
NTA/LTD (C)	ELM or 356
LTD/Capitalization (C)	OAK or 625
Total Debt/Capitalization (C)	JOT or 568
Forecast Data	FOR or 367

Figure 11. WINS Directory

any single report. Column of numbers on the hard copy report, familiar to the managers are presented in the same order on the screen.

(4) Menu display must be simple.

The first principle resulted in the design of a 10 button "princess telephone" type entry device connected to the desk top TV screen which in itself was consistent with the manager's normal usage of the telephone. The only additional control at the desk top terminal was a three way switch mounted on the chassis of the TV monitor.

6.3.4 Software Programs

A user of WINS is capable of calling up five types of information from the core report, and to use four types of corporate models for analysis and planning. The five versions of the core report are:

(1) Financial Information (This program enables the user to call individual items of information using a directory of available items and units which shows individual identification codes - Figure 11.)

(2) Fixed Information Items (Similar to first program except it is designed to eliminate the need for repeated keying in the same information item when a series of displays of the same item is shown for a variety of different units.)

(3) Fixed Organization Unit (Similar to second program except designed to eliminate the need for repeated keying when all information is requested for a single unit.)

(4) Exception Analysis and Display (This program allows the quick determination of trouble areas and permits the analysis and segregation of only those items that indicate unfavorable performance against the planned objective.)

(5) Exception Display Only (This program keeps in memory the last exception display analysis that was prescribed and eliminates the need for cycling through the Exception Analysis and Display sequence.)

Five types of corporate models have been planned for incorporation into WINS software programs:

(1) Break-Even Analysis Model (Is currently operational and performs various standard break-even and profitability calculations.)

(2) Sales Growth Model (Is currently operational and determines the sales growth rate that can be financed per a prescribed set of assumptions for working capital and fixed capital requirements, return on sales, leverage and dividend payout.)

(3) Source of Profits Model (Is currently operational and is used to analyze the source of a company's profit.)

(4) Stockholder Return Model (Being reprogrammed, not practical to use in present form.)

(5) Earnings Growth Model (Being reprogrammed, not practical to use in present form.)

6.4 Operational Characteristics

6.4.1 General

In recent months usage of WINS has generally fallen off, both in the board room and in the office terminal. WINS has not had any significant influence on the management style of the senior corporate managers. According to Mr. Menck this trend is due to three factors:

(1) The CEO is color blind, and the system has been unable to adapt to his changing interest and personnel information needs.

(2) The senior executives seldom get together in each other's offices, and most of them as individuals have not built up a trust in the use of interactive computer systems.

(3) Hard copy, as personified in the printed "core report" is more desirable and reliable. (Most active users are young executives who used computers in their college courses.)

6.4.2 Internal Security

Security for WINS is relatively simple since there are only a small number of terminals and users who are all located in one general office area. Since the system is a computerized-graphic version of the "core report" it accords the same level of classification. The Gould Company has an "open door" philosophy towards its management system and operational data, and the core report receives a wide distribution through the organization. However each user does have a 5-digit password to allow him access to a program menu and use of WINS.

6.4.3 Training

Virtually no training is necessary to operate the WINS terminal. Aside from normal TV type controls for Scan Size, Contrast and Bright, the user need only use the telephone like push button box in response to menu offerings. One needs only a directory of the type shown in Figure 11 and a 13 page memo which describes six data sources and six analytical models.

7. GEO-DATA ANALYSIS AND DISPLAY SYSTEM (GADS)

7.1 Operational Environment and Major Events

GADS development was initiated in the early 1970's by the IBM Research Laboratory in San Jose, California as part of a research program to study the use of DSS by non-programmers to solve unstructured problems effectively. The program focused on the solution of problems involving data which could be related to geographical locations. Unlike IRIS, EIS, and WINS the objective of the GADS project was to understand the process of user-computer-aid graphics decision making, both in the individual and in the group consensus modes of operation. From the beginning GADS was regarded as an experimental research effort and not as a development-implementation effort to meet specific user requirements. Most of the funding for GADS development was provided from IBM's own internal research program. This emphasis is reflected in the number of research papers that have appeared in the literature. A majority of these papers have focused on the problems of training managers or other professionals as DSS users, or on the more academic problems of evaluation and design methodologies. Although the basic GADS configuration has never been institutionalized in any specific organization, the IBM research group has made extensive contributions to DSS technologies in general. For example, the consent of a skilled intermediary or "chauffeur" came from the IBM group. This "integrating agent" acted as 1) an "exegetist" who explained the DSS to the user, 2) a "crusader" who sold the system through personal enthusiasm, 3) a "confidant" who built up the user's self-confidence and acted as an advisor, and 4) a "teacher" who provided personalized instruction.

By early 1973 IBM researchers recognized the need for a field laboratory, and established a working agreement with a local governmental agency, the Center for Urban Analysis in Santa Clara County, California (San Jose is the major city in this county). Fortuitously in 1973 the Center for Urban Analysis received a LEAA grant for research in the criminal justice area, and the San Jose Police Department faced a major problem in developing a more efficient manpower deployment system for the schedule of police beats. The existent scheme had been devised in 1965 and was unable to cope with rapid population growth and geographical relocations which resulted in high workload areas, unstructured field patrols, backlogs for police service and an unhappy public. A joint services agreement was established between the Police Department and IBM researchers with the Center acting as a conduit for federal funds and a certain amount of technical support. Other similar joint services agreements were established in the San Jose area which provide that IBM would provide free computer time, software support, and technical support for system modification with other public service agencies. Although no major functional changes have been made in the GADS configuration since June 1974, the research program has resulted in over 16 different applications, and experience with the training of over 200 users with no previous experience with computer systems. GADS has evolved as an experimental general purpose DSS for computer-aided decision making in the public sector. Roughly one third of the applications were in the police field, one third in the social field related to redefining school district boundaries, planning for urban growth, etc., and the remainder in such diverse areas as establishing fire protection districts. The sole non-public sector application was the internal IBM application to the problem of assigning service territories to customer engineers. This last system was designed for use by Field Managers (first level managers) in IBM's Office Product Division.

7.2 Architecture

7.2.1 General

GADS is a computerized interactive graphics system that essentially draws maps which provide decision maker(s) with tools for analyzing data categorized in terms of geographic coordinates. There are no sophisticated operations research models or statistical software packages available to the user. The system is designed to provide a data abstraction and presentation language in a multitude of colors to aid a user in

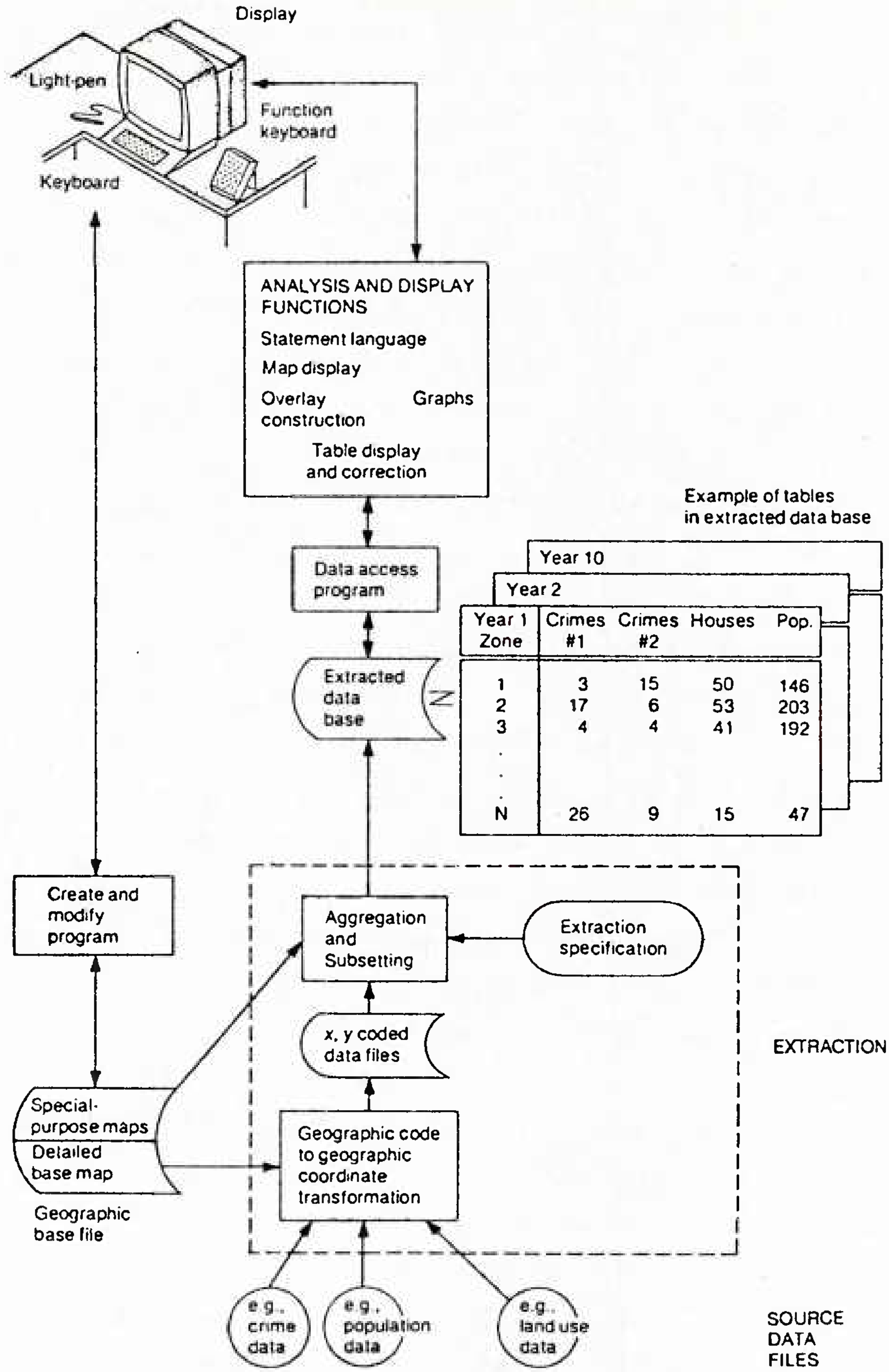


Figure 12
GADS Architecture

spatially oriented resource allocation problem solving. The basic GADS architecture required complex data management software and data preparation which was provided by IBM in the experimental applications until 1976. Major changes had to be made prior to operational use by public sector agencies to provide for programming support and maintenance. After 1976 most of the 15 experimental applications in the public sector were phased out or extensively modified. The San Jose police adaptation of the original GADS represents the closest generic variation, and successful operational system.

The GADS-Police Beat application is also a good example of the problems of designing the proper balance between a data-oriented system and a model-oriented system. In the initial stages of development it was decided that a heavily data-oriented would provide a better alternative than the then existing manual and heuristic scheme for allocating police manpower to areas (beats). Reports were generated on police calls-for-service, workload, response times, etc. The relevant data was plotted manually on maps, and police management used the maps to develop and evaluate alternative decisions. The result was an allocation plan which was more expensive and farther from the quantitative objectives (e.g., balanced workload) than the existing scheme. Next, an operations research consultant was asked to help make the decision using a model-oriented DSS to determine an "optimal" plan. The consultant interviewed decision makers, developed objective functions, collected the "relevant" data, developed an allocation model, and ran the model to make the decision. The resulting plan was rejected by police management because it violated several qualitative objectives which could not be incorporated into the model. Finally a DSS of the type shown in Figure 12 was provided for the decision makers. The DSS was used by the decision makers to develop a manpower allocation plan, a variation of which is still in use. Consequently our focus in looking at the GADS architecture and operational characteristics will center primarily on the Police Beat application.

7.2.2 System Software and Hardware

The basic GADS architecture is shown in Figure 12 and reflects the emphasis on and the complexity of data management software and data preparation. The experimental GADS implementation was in FORTRAN, using IBM's Graphic Subroutine Package. The system runs on an IBM 360/195 under the OS/MVT operating system and Time Sharing Option (TSO). The system requires 175 bytes of main storage, and it has been run on an IBM 360/50. The user terminal is an IBM 2250-3, a refreshed CRT with vector graphics and character generation. The user interacts with the display using a light pen, an alphanumeric keyboard, and a programmed function keyboard. The extracted data base is stored on disk.

7.2.3 GADS Data Extraction

The basic GADS architecture as shown in Figure 12 reflects the importance of data management software and data preparation, as well as a color display terminal with a high resolution capability with minimum flicker (in excess of 1024 x 1024 characters). GADS data extraction is a process whose inputs are a set of source data files, a Geographic Base File (GBF) containing computerized maps, and an aggregation and subsetting specification, and whose output is an on-line, extracted data base. Each source record contains a geographic code (such as an address) so that extracted data can be related to points, lines, or polygons on a computerized map. A detailed base map in the GBF is used during extraction to transform the geographic codes in the source file records into geographic (x, y) coordinates. Special purpose maps (such as a set of zone outlines) are then used for aggregations of the data. To keep the GBF accurate and to enter the special purpose maps required for each application, a GBF "create-and-modify" program provides crucial support.

GADS users supply a list of source files, data names (logical and/ or arithmetic) for any combinations required to select, aggregate, or compute data for an extracted data base. In the Police Beat example shown in Figure 12, an extracted data base for crime analysis is formed from: source files containing 10 years' data on crimes, land use, and population; a special purpose map of police beat-building-blocks (basic zones); and an extraction specification for computing 20 crime categories and selecting population and number of houses by year. The result is 10 tables (one for each year) giving crime by category, population, and number of houses for each basic zone.

A totally integrated data base of source files is an alternative to an extracted data base and would eliminate redundancy between the extracted data and the source files. This alternative was rejected because:

(a) aggregation and subsetting would have to be performed dynamically;

(b) for any application all the relevant source files would have to be on-line to support conversational GADS use;

(c) protection of the source files would be more difficult;

(d) GADS would be dependent on the existence of an integrated data base.

7.2.4 GADS Analysis and Display Functions

GADS embodies two important design goals for the analysis and display functions. First, the functions should support a set of applications using geographic data. Second, the functions should be powerful enough to meet the data manipulation requirements of users who are application specialists, but simple enough so that each function could be learned in a few minutes. To achieve these two goals the following strategies are used. The analysis and display functions, chosen on the basis of our study of potential applications, are presented as a set of major functional groupings which the user can learn and invoke depending on his problem requirements and his solution approach. Within each grouping, functions are divided into levels. A user can progress from the basic levels to the more complex during problem solution. Data storage and display in terms of maps serves as a natural framework for unifying the functions. The five major groups of functions are:

(1) Statement Language which essentially provides command language to users for saving, editing, calling up data elements, invoking dynamic aggregation, etc.

(2) Map Display which support display of statement-created symbols on map, change scale and display zone numbers and data values for any symbol.

(3) Overlay Construction which provide ability to create overlay maps or save maps in library.

(4) Graphs are a second method of display for one, two or three dimension with automatic or manual axes scaling.

(5) Table Display and Correction provides a third display mode and method of correction.

7.3 Operational Characteristics

7.3.1 Security and Evaluation of Public Sector Systems

Internal security for either users or data storage has not been a major concern in the public sector applications of GADS. Nor has cost/effectiveness or on-line evaluation since most of the individual applications were funded from federal or IBM research funds. Extensive efforts were made to determine the value of the GADS Police Beat system; per sè.

In both interviews and questionnaires the police officers unanimously responded that using GADS improved their understanding of the beat structuring problem and resulted in a better solution than would have been obtained from alternative approaches. The officer acceptance of the GADS solution was in contrast to their earlier rejection of an "operations research" solution which a consultant supplied. Comparison of the GADS solution with the existing beat structure indicated that the GADS solution had half the range and variance of officer workload per beat. Solution using GADS took longer than the four hours for a previous, manual solution, but much more data was analyzed, many more alternatives were investigated, and eleven people instead of two were involved.

GADS was used to explain the solution process to other police officers and to city management. A change in manpower availability necessitated a reduction in the number of beats in the final solution from 43 to 40. One officer, with assistance from three others, spent 42 man-hours using GADS to construct a new beat plan. The data displays stimulated officer insights on zone accessibility, neighborhood characteristics, travel time, and personnel and equipment characteristics. These insights developed only during use of GADS, and it is not clear that they could be coded as computer data and incorporated into automated solution procedures. The general question of evaluation of DSS in the public sector is still unresolved. A San Jose Police Lieutenant who has worked with the GADS-Police Beat project continuously since 1973, summarized the state of public sector DSS development when he stated, "We still don't know how to write performance specifications."

7.3.2 Individual and Group Training

A total of fourteen police personnel worked on system design. There were five main users of GADS: two lieutenants from Field Operations, one from Research, a staff assistant from Research, and a sergeant assigned to communications. Five other field personnel were brought in when special knowledge of local conditions was needed. Over 350 hours of effort were required to create the data base, and IBM personnel spent 6 months developing programs for data management and 40 hours entering the special-purpose map defining the beat-building blocks (BBB). Since police personnel using the GADS system had little or no experience with computers, a certain amount of familiarization and pre-training was necessary. IBM personnel instructed the four primary development teams on various elements of system operation. Individual training included familiarizing personnel with the mechanics of the system including giving demonstrations on how BBB's were entered into the system, how calls for service were assigned X-Y coordinates, and the procedures for moving through the system. This training took approximately <u>four hours</u> of classroom familiarization plus another <u>six to eight</u> hours of actual data manipulation using the scope.

Since the actual design of a GADS-Police Beat system was dependent on group decision making, four teams participated in developing the deployment plan. Each team consisted of two primary members; however, additional personnel who had useful operating experience in specific areas were used in the decision process. GADS is unique in that the decision process can be taken to any organizational level and the process of making a determination can be quickly reviewed any time during the process. By expending approximately 15 minutes of time for orientation and explanation, a primary team member was able to involve operational personnel not familiar with computers or GADS in the process. On several occasions, team members switched or worked alone without adversely affecting the quality of decisions reached. Although an "overall" decision making plan was outlined, each team ended by deciding on its own particular process and problem approach. Several teams abandoned their initial approach as data began to be manipulated and users became more comfortable with GADS. All teams "adjusted" their thinking several times during the decision process until an overall consensus was reached between the teams. The current operating system still has the capability of individual or team usage, and training times are about the same as in the early experimental model.

8. CONCLUSIONS

8.1 General

From a limited survey of only four types of DSS, it is concluded that there are a number of similarities and differences in their gestation environments, major events in their developmental cycles and in their operational characteristics. There are major differences in the development of public sector DSS vis-a-vis private sector DSS. Research and development procurement, operating and maintenance policies in the public sector are all dependent on contract specifications related to performance or accomplishment of a specific task(s). Yearly budget cycles and bureaucratic management processes greatly handicapped the application of GADS technology. On the other hand IRIS, WINS and EIS were developed within a corporate structure which could respond rapidly to user, managerial, and technological change. Since DSS are by their very nature evolutionary and designed with a capability for architectural adaptability, the most successful systems were found in the private sector. Of the four systems surveyed, IRIS represents the best overall example of an operational DSS which has become institutionalized in an organizational setting, is capable of adaptation, is used by both corporate staff and operational unit managers for both strategic and tactical decision making, has an effective internal security system, has a good training program, has an effective on-line operational cost/effective evaluation system, and satisfies the dual perceptions of the senior corporate executives as well as the operating field units. On the other hand WINS is more of an example of the ideal DSS. It was designed for use by the CEO and senior executives, both in the "board room" group mode and individual desk top mode, and is equipped with elaborate color graphics and software decision models as well as an aggregated data base all driven by a minicomputer slaved to a mainframe. EIS has the largest number of different individual users and different types of decision problems, and provides the test bed for the open market IBM Trend Analysis/370 system. Finally GADS provided an experimental test vehicle for over 15 public sector and one private application, and has made a number of major contributions to the research literature.

There were a number of similarities that all systems exhibited:

(1) An average of three to four years were required for development and implementation.

(2) Each system had the strong support of the senior management or Chief Executive Officer when development was initiated.

(3) All systems had a "broker" who coalesced user, technical and management interests for common support of development and implementation.

(4) All systems had a capability for evolution or "architectural adaptability."

8.2 Internal Security

User access and data protection were major problems of internal security for multi-level users in widely distributed locations. IRIS and EIS both had elaborate "access" and "need to know" password procedures. They were designed with the objectives of accommodating both corporate and operating unit perceptions, and were tailored to the identity and responsibility of the individual user. Thus the system not only protects the confidentiality of personnel data, but preserves the organizational and managerial integrity of the whole corporation. On the other hand the WINS system required a relatively simple system since the whole system was physically located in the corporate office and boardroom area, and had only a limited number of senior executive users. None of the GADS public sector applications placed much emphasis on internal security.

8.3 Use of Central Data Base

All of the public sector DSS were appendages to, or integrally related to central data bases. At the one extreme the WINS minicomputer at corporate headquarters was slaved to a large regional computer center mainframe in another state. At the other extreme the IRIS Project Group controlled and managed the entire RCA personnel management data base which is used jointly for MIS transactional activities and for DSS type ad hoc decision making. EIS was designed to operate both from its own data base, or as an appendage from operational with the First National Bank System.

8.4 Training Programs

All of the DSS had some form of user training programs, which included formal instruction, user manuals and a staff "coordinator" or "chauffeur." WINS was the simplest to use and could be done by self-teaching. GADS required 4-8 hours for a non-programmer user to become proficient, whereas EIS normally required two days of instruction.

IRIS requires the most extensive training program because of a wider range of user skills at a number of corporate and field unit sites with continuous updating of system capabilities and turnover of personnel.

8.5 Operational Cost/Benefit Procedures

IRIS was originally designed to meet a cost per employee criterion, and has the most extensive on-line evaluation capability. EIS requires that each "profit center" user pay for terminal leasing, start-up cost and computer transactions through internal funds transfers, but has no effective on-line evaluation program. Neither WINS or GADS reported any major effort at cost/benefit analysis of system operations. However a number of researchers have attempted to evaluate the "value" or "utility" of some of the GADS applications.

9. RECOMMENDATIONS

9.1 DSS Workshop

AIRMICS should take immediate action to organize a DSS workshop with representation from successful operational systems, hardware and software vendors, academicians representing the major disciplines involved in DSS research and development, and potential Army users. The workshop should include case studies, tutorials, theoretical discussions, view of technology and hands-on demonstration of operational DSS. This workshop would be a natural follow-on to the Santa Clara Conference of 1977, and would do much to synthesize and establish a baseline for future research efforts and prototype Army field applications.

9.2 Evaluation and Performance Specifications

As concluded in 8.1, a serious problem exists in the design and implementation of DSS in the public sector because of their intrinsic evolutionary nature which makes evaluation and contract performance specification virtually impossible, and in serious conflict with the life cycle-sequential DOD procurement policy. It is recommended that a research effort be initiated to examine the current state of DSS evaluation methodologies and their compatibility with DOD procurement policies, and to recommend alternative solutions.

9.3 Improvement of DSS Survey Methodology

The survey reported here was both limited in man-days of effort and size of sample. Consequently much of the field work and literature review were accomplished simultaneously. The development of a methodological set of factors and attributes did not take place until work began on the final report. It is therefore recommended that after a review and critique of this report is completed, that a second iteration be initiated with a refined set of factors and attributes. The second iteration would be directed at an investigation of a more selective target set of operational systems which could provide a more definitive baseline to guide the Army in applying DSS technologies to Army computer systems.

Appendix A

STATEMENT OF WORK
TCN: 78-368

Short Term Advisory Services (STAS)

1. General

The Army Institute for Research in Management Information and Computer Science has a requirement for the services of an Operations Research Scientist to undertake a short term project to produce a state-of-the-art survey and analysis of the application of Decision Support System (DSS) technologies to business type automatic data processing systems. This study is beyond the present capabilities of AIRMICS personnel.

2. Objectives

The work to be accomplished between 15 Sep 1978 and 15 January 1979 is to produce an analysis of existent DSS and their supporting hardware and software technology base, and to recommend further research into potential application of this technology to computer systems.

3. Specific Tasks

a. Gather and analyze published work on DSS developed for use in the civilian community.

b. Review and analyze reasons for success or failure of DSS developed for civilian use. As a minimum the following known installations will be queried: RCA; Gould, Inc. ; First National Bank of Chicago; IBM.

4. Reporting Requirements

A report will be submitted by January 15, 1979 which reflects the activity, purpose, procedures, documentation and summary of work performed under each task in paragraph 3. In addition this report will include a list of recommendations for future research.

5. Special Qualifications

The Operations Research Scientist selected for these services must be at the Ph.D. level with a background in computer applications, in systems engineering, and man-machine design methodologies.

6. Place and Period of Performance

a. Twenty working days during the period ~~15 Sep 1978~~ 30 Aug 78 and 15 Jan 1979. which includes 50% of work at AIRMICS, or ten days. Travel will be as follows:
(1) One trip to Ft. Lee, VA of 1-2 days duration: (4) One trip to Gould Corp. Chicago, Illinois of 1-2 days duration.
(2) One trip to IBM, San Jose, CA, 1-2 days
(3) One trip to RCA, Summerville, N.J. 1-2 days duration.

7. Restrictions

There is no known potential conflict of interest associated with this task.

R

Appendix B

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